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Research and development of haptic simulator for Dental education using Virtual reality and User motion

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Abstract

The purpose of this paper is to develop simulations that can be used for virtual education in dentistry. This development goal is to allow dental students to learn the necessary surgical techniques at the point of their choice, not going into the operating room, away from time, space, and physical limits.

In this paper configuration, the optimization method is applied convergent, and when the operation of the VR contents is performed, the content data is extracted from the interaction analysis formed in the VR engine, and the data is processed by the content algorithm. It also computes events and dental operations generated within the 3D engine programming and generates corresponding events through data processing according to the input signal.

The visualization information is output to the HMD using the rendering information. In addition, the operating room environment was constructed by studying lighting and material for actual operating room environment. We applied the ratio of actual space to virtual space and the ratio between character and actual person to create a spatial composition at a similar rate to actual space.

Keywords: *VR interactive system, VR, HMD, Outside-in tracking system.*

1. Introduction

In recent years, the growth of mobile devices such as PC, smartphone, tablet PC, etc. has been decreasing, while global leading companies of ICT technology, Google, Apple, Microsoft, PayBook, Samsung Electronics, Virtual Reality (VR) technologies are evolving. As a result, Head Mounted Display (HMD) and other products such as Oculus lift, Samsung gear VR and other products are being released [1].

However, despite these hardware developments, the lack of content in various fields has hampered the development of a balanced VR industry [2].

Virtual Reality (VR) is a technology that makes use of the interface between humans and computers, makes a certain environment or situation computerized, and makes it appear to interact with the actual environment and environment.

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Currently, VR is being used for educational purposes, and it is mainly used in practice of surgeries in hospitals or over-hygiene, virtual terror suppression exercises in the military, simulation training in tanks and aircraft, etc. The development of Head Mounted Display (HMD) The development of contents is actively used in games, education, medical, movies, performances, amusement parks, real estate, manufacturing, etc. In Korea, portal companies and game industry are making great strides in virtual reality. Especially, SMEs are producing games and video contents.

The HMD for VR used in virtual reality classifies VR according to the type, and is divided into PC VR and Mobile VR. VR for PC is divided into Oculus Rift [3], HTC Vive and Sony PSVR, and Mobile VR is divided into Samsung Gear VR [4], Google Cardboard and Google Daydream. In addition, VR classification according to contents type is classified into image-based VR and graphic-based VR. Image-based VR is divided into 360-degree video and Fang (ex. Netflix), and graphic-based VR is divided into VR game and VR experience [5].

In this paper, we use VR system and contents for clinical training and practical case data of extraction for dental education. By using the developed system, students of dental school will be able to go beyond the time, space, and physical limits of the surgery room, learn the necessary surgical techniques at the time of their choice, or use VR want to develop.

In order to develop such VR contents, we want to construct and design the whole system considering 360VR image, physics engine 3D programming, human factor optimization, NUI interaction function definition, maximizing educational effect, interest and immersion degree.

In addition, motion controller VR interactive using HMD is applied to the content to be developed so that per-object recognition is possible. In order to do this, we erroneously design realistic contents or information which is virtualized with various data or information such as text, image / CG, voice related to the five senses of object in the realistic virtual reality space modeled. And it is expressed in virtual space realistically in cooperation with various peripheral devices. We want users to experience the contents through various sensory organizations.

2. Background

The Oculus Rift is a Virtual Reality (VR) HMD (Head Mounted Display) developed by Oculus VR. It has a resolution of 1080 × 1200 on both the right and left sides in a wide field of view [6]. The first development of Oculus Rift started with the Kickstarter (Crowd Funding Site) campaign.

The lift has integrated headphones for 3D audio effects. The lift traces its rotation and position, and when you turn your head, the direction is shown on the screen. Location tracking is performed by a USB fixed infrared (IR) sensor, which typically places it on the user's desk, allowing the user to sit and stand, or walk around the room and use the lift [7].

The oculus lift used in this paper consists of foam padding, lens, lens holder, lens barrel, HD display, electric circuit board and cover from the outside. Lenses are available in three sizes, each of which can be selectively changed depending on the presence or absence of glasses and the visual acuity. The software divides the main screen into left and right curved screens, each providing a panoramic view.

Also, the distance between the eyes and the lens can be adjusted through the dial attached to the lens barrel.

3. System Configuration

3.1 System construction

Oculus Rift HMD, Optical Based Outside-in Tracking System, Oculus Touch Motion Controller, and Headset as Input / Output Device. In the operation of VR contents, the data formed through the analysis of the interaction generated in the VR engine was processed by the contents algorithm.

Computes events and dental operations within 3D engine programming. The corresponding event is generated through data processing according to the input signal, and the rendering information is output as visual visualization information by the HMD.

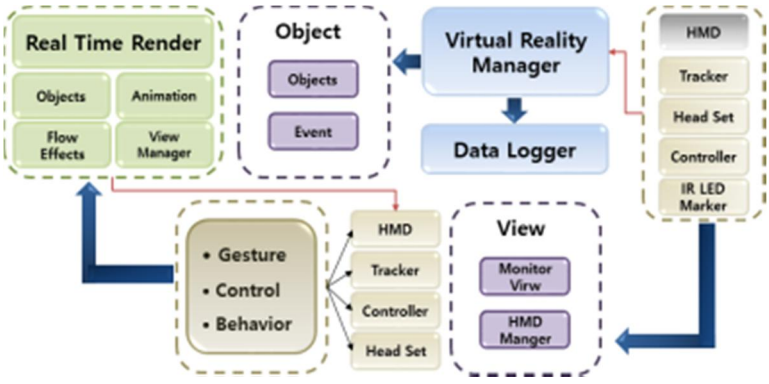

Figure 1. Development system of composition

As shown in Figure 2, the Viewer Manger analyzes the information of the interface used in the virtual reality device. Based on the analyzed information, the data logger will load and save. Finally, the virtual reality manager configures and implements the system behavior of the content by executing effects and animations according to the corresponding event elements (see Figure 2).

3.2 Scenario Configuration

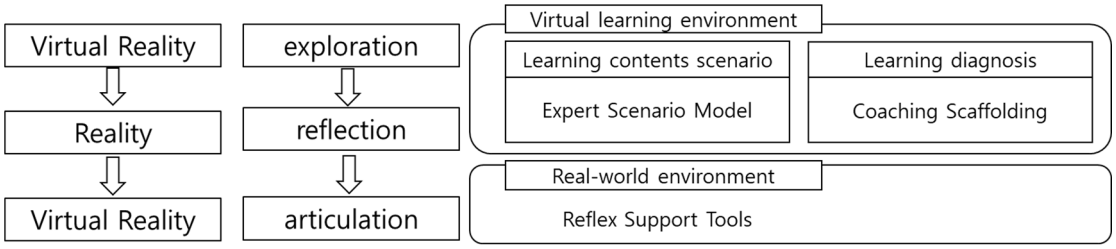

Figure 2. Scenario conceptual diagram of VR dental extraction contents

Scenario configuration and virtual reality based dental extraction contents were designed and constructed for scenarios and storyboards considering learner's cognitive load. Although the proposed scenario is intended to observe the entire dental procedure, it is structured so that concept information, detailed treatment procedures, and step-by-step procedures can be confirmed as needed.

In this paper, based on the progress of the surgical procedure for the third molar, which is the subject of extraction, provides step-by-step demonstration of procedures, providing additional information related to the procedure stage, tool name, description and demonstration of the principle, and editing of key scenarios

such as precautions during diagnosis and treatment. The storyboard structure of this study was divided into basic contents structure of the dental extraction process (preoperative, postoperative, and postoperative), actual VR mode and 3D VR clinical technician mode, And an object and animation scene through 3D engine programming. It is also designed to selectively or entirely process the contents according to each situation through UI function switching.

4. System Development

In this paper, we design and develop motion controller VR interactive system using Oculus Rift HMD.

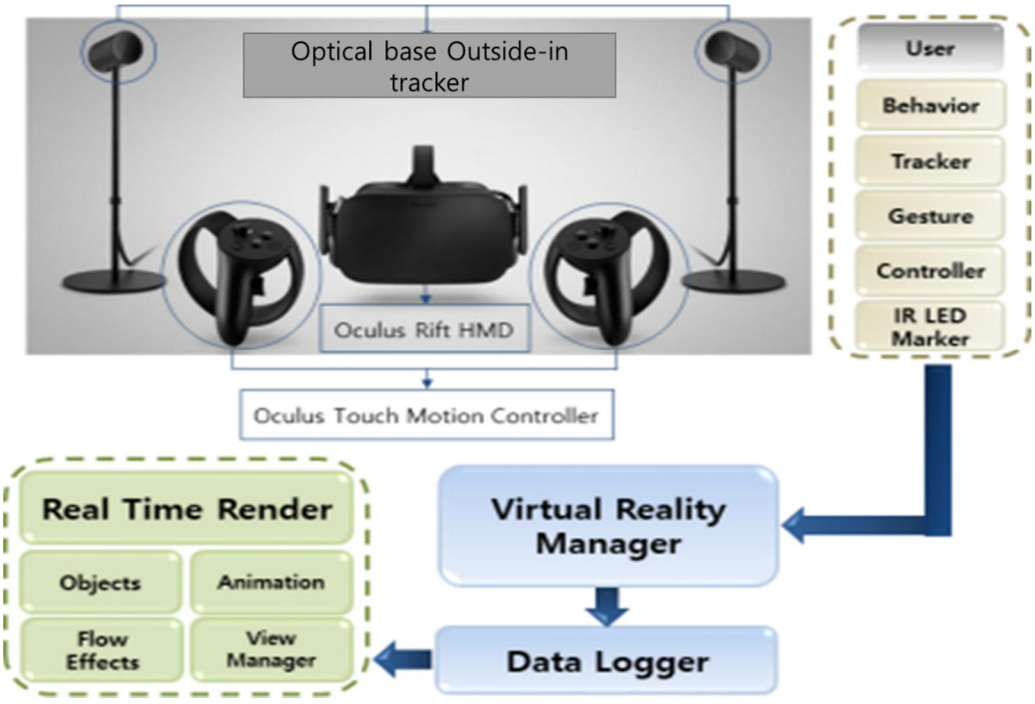

Figure 3. Development system of composition

Figure 3 shows the configuration of the VR interactive system process. The system consists of Oculus Rift HMD, Optical based Outside-in tracking system, Oculus Touch motion controller, and Headset as input / output device.

Figure 4. Realization of motion-based motion based interaction using HMD

Figure 4 shows the implementation of the interaction function using the Finger Stuff, which is the Trigger button function of the Oculus Touch controller, for effective control when constructing the VR contents after testing the usage environment after wearing the HMD.

It is designed to minimize the sense of heterogeneity due to the timing synchronization and rotation angle according to the screen synchronization.

In addition, realistic screen expression is made through 360 degrees free time expression according to the movement of the head wearing HMD such as front, left / right turn, left / right tilt, and up / down rotation. As shown in Figure 5, it was determined that the center coordinates calculated from the eye image obtained from the inertial sensor were gazed at on the monitor, and the geometric positional relationship between the pupil center and the monitor plane was confirmed.

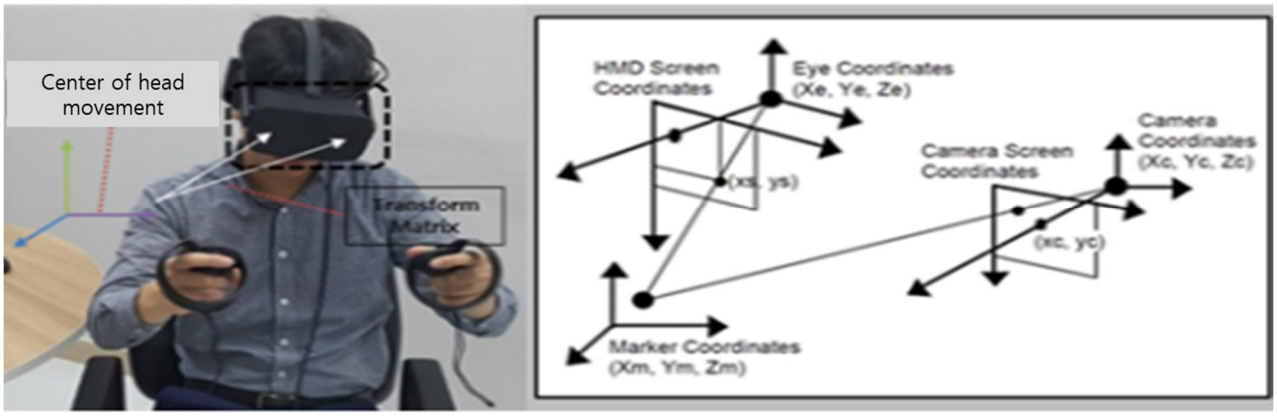

Figure 5. Relationship between centers of acquired image coordinates and position on monitor for center point coordination of head movement

4.1 Implementation of surgical procedure animation

Figure 6 shows a real-world texture (skin, blood vessel, teeth, teeth, tongue, lip, etc.) in the 3D Asset modeling technique applied shader using real human texture data to maximize the realization of teeth.

Figure 6. Apply shader using real person's texture data

4.2 Render to Texture

The materials and shaders used in this study can be applied to maps of Albedo Map, Normal Map, Height Map, Occlusion Map and Detail Mask of the main map. In this study, more than 4 textures were applied as shown in Figure 7. because the 3D engine has limitations on materials that can be expressed compared to passive rendering, realtime 3D engine uses Passive rendring to render light, materials, and text in the object scene into 2D objects Render to texture method maximizes texture.

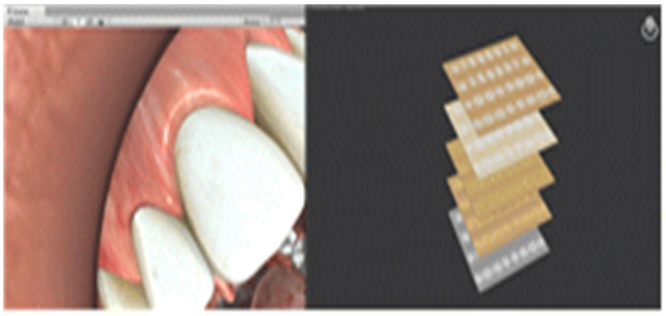

Figure 7. Render to Texture

As shown in Figure 8, the medical chair consists of a medical chair part where the patient is laid and treated, and a medical machine part composed of tools for medical treatment and surgery such as lighting, suction, electric drill, and ultrasonic scaler.

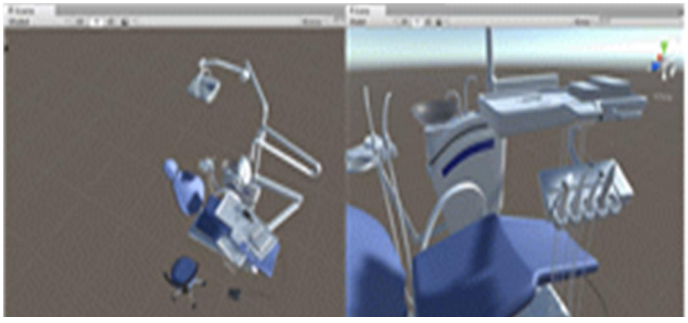

Figure 8. Configuration of medical chair

In addition, by implementing animation according to the actual operation situation, the basic tools of dental extraction, such as extraction tool root picker, hand piece and bur, high shear feeder, low speed straight line angle, And the implementation method for each procedure was set according to the procedure. The process of pre-dental surgery, surgical procedure, and post-operative procedure was developed as a process.

5. Conclusion

Augmented reality technology is used in various industrial fields, and it is applied to industry, medicine, science, entertainment, etc. In museums, it is utilized to promote understanding and interest of viewers. At present, it is evolving from a game and a museum to a rigid and funny learning form by using augmented reality technique.

These developments are making rapid progress in stimulating the interests of medical study and maximizing the sensation by the augmented reality and storytelling technique.

In this paper, the technology applied to the dentistry is implemented as "scenario composition and virtual reality dental extraction contents." Although the entire dental treatment procedure is observed, the concept information, detailed treatment procedure and stepwise treatment contents can be confirmed as needed.

The techniques applied in this paper will help to develop the paradigm of medical field applied augmented reality technology.

Acknowledgement

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References

[1] Hojun Son, Hyoung joon Jeon, Soonchul Kwon, Kwangchul Son, Jisang Yoo, "Study on Distortion and Field of View of Contents in VR HMD," International Journal of Advanced Smart Convergence, Vol. 6, No. 1, pp. 18-25, 2017.

[2] Jahanzeb Hafeez, Seunghyun Lee, SoonchulKwon, Alaric Hamacher, "Image Based 3D Reconstruction of Texture-less Objects for VR Contents," International Journal of Advanced Smart Convergence, Vol. 6, No. 1, pp. 9-17, 2017.

[3] "The Oculus Rift, Oculus Touch, and VR Games at E3". oculus.com. 2015.

[4] "Powering the Rift". oculus.com.

[5] G. Yu, F. Ding, H. Wei, Z. Zhao, Z. Liu, Z. Bian, L. Xiao, and C. Huang, "Highly efficient terbium(III)-based organic light-emitting diodes obtained by exciton confinement," J. Mater. Chem. C, Vol. 4, No. 1, pp. 121-125, 2016.

[6] Hafeez. G, Seunghyun Lee, Soonchul Kwon, Alaric Hamacher, "Image Based 3D Reconstruction of Texture-less Objects for VR Contents," International Journal of Advanced Smart Convergence, Vol. 6, No. 1, pp. 1219-17, 2017.

[7] Jongho Choi, Soonchul Kwon, Kwangchul Son, Jisang Yoo, "Fast key-frame extraction for 3D reconstruction from a handheld video," International Journal of Advanced Smart Convergence, Vol. 5, No. 4, pp. 1-9, 2016.